# →UAS4Enviro2017

## small Unmanned Aerial Systems for Environmental Research

5th Edition

# ABSTRACT BOOK

**28 – 30 June 2017 | UTAD | Vila Real, PORTUGAL**

ISBN: 978-989-704-241-6

# ADAVANTAGES OF USING UAVS DATA TO STUDY ROCKY COASTS GEOMORPHOLOGY: THE CASE STUDY OF THE SÃO PAIO ROCKY LITTORAL, PORTUGAL

Lopes, Mafalda (1), Marques, Miguel (2), Coelho, Cláudia (3), Araújo, Maria Assunção (4), Gomes, Alberto (5),

*(1) Faculdade de Letras da Universidade do Porto, Via Panorâmica, s/n 4150-564 Portugal, mafalda.lopes7@gmail.com*
*(2) Geolevação, geoelevacao@gmail.com*
*(3) Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre 1021/1055, 4169-007 Portugal, coelho.claudia91@gmail.com*
*(4) Centro de Estudos de Geografia e Ordenamento do Território (FLUP), Via Panorâmica, s/n 4150-564 Portugal, m.a.araujo@netcabo.pt*
*(5) Centro de Estudos de Geografia e Ordenamento do Território (FLUP), Via Panorâmica, s/n 4150-564 Portugal, albgomes@gmail.com*

**Key-Words:** UAVs; rocky coast; costal geomorphology; geological mapping.

**ABSTRACT:**

Rocky Coasts comprises about 80% of the coasts of the earth [1]. Along the European oceanic coast, this type of littoral constitutes 1/3 of the coast (about 3666 km) representing approximately 37% of the total length [2]. According to the same authors, 48% of the rocky coasts develop in outcrops of resistant rocks, such as granites and limestone's. Despite their relevance in quantitative terms, the rocky coasts receive less attention from the scientific community when compared to the sandy coasts. This fact is associated with urban, industrial or recreational uses and pressures [3], and the assumption of high social and economic value for the sandy coasts [4].

The studied area covers the coastal stretch of São Paio at Portugal, located at Vila do Conde municipality, 15 km at north of the Douro River and the city of Porto. It differs from the typical coast of the Porto region, generally low, since it consists of a rocky coastal stretch characterized by two massive granite small hills (Mota hill, north and the Facho hill, in the south), separated by a small beach, called Castros beach [5].

This study presents an integration of classical fieldwork with new technologies into the geomorphological and geological research of rocky coasts, namely by the acquisition and analysis of images captured by autonomous unmanned vehicle (UAV) and further processing of the collected data. From a collection of aerial photographs (5 cm of pixel size), it was made a global orthoimage of the area and produced a digital terrain and a surface model. These data were the basis for the elaboration of detailed geological and geomorphological maps, which are the main results presented.

The specific characteristics of flights with an UAV (low altitude flight) allows images that offer many advantages, such as, excellent resolution, large overlap and reduced execution time [6]. In this survey, it was used a Hexacopter device (± 2700g of weight), class 550 with a controller 3dr APM for Arducopter 3.6 and with a time of operation of 12 - 16min. The image acquisition was performed from an UAV equipped with a conventional Canon Powershot sx260hs (12 megapixels) digital camera whose memory card has an application (CHDK-Canon Hack Development Kit) that allows shooting automatically within a certain time interval set by the user.

In order to improve the quality of the images obtained, the flights were executed on 08/12/2014 and 01/23/2015, days with low cloudiness and during spring low tides, with the objective of shot in detail and

clearly the marine erosion platforms and boulders that are usually covered by the sea. A recent survey and flight was done in April of 2017, in order to evaluate the shore dynamics and changes occurred between 2014-2017. In addition, some control points (marked with red crosses on the terrain surface and in observable positions on the aerial photographs) were also collected using a LEICA SR20 differential GPS. The subsequent tasks to process data in order to match the photos and obtain the respective DTM and DSM are briefly exposed in Fig. 1.

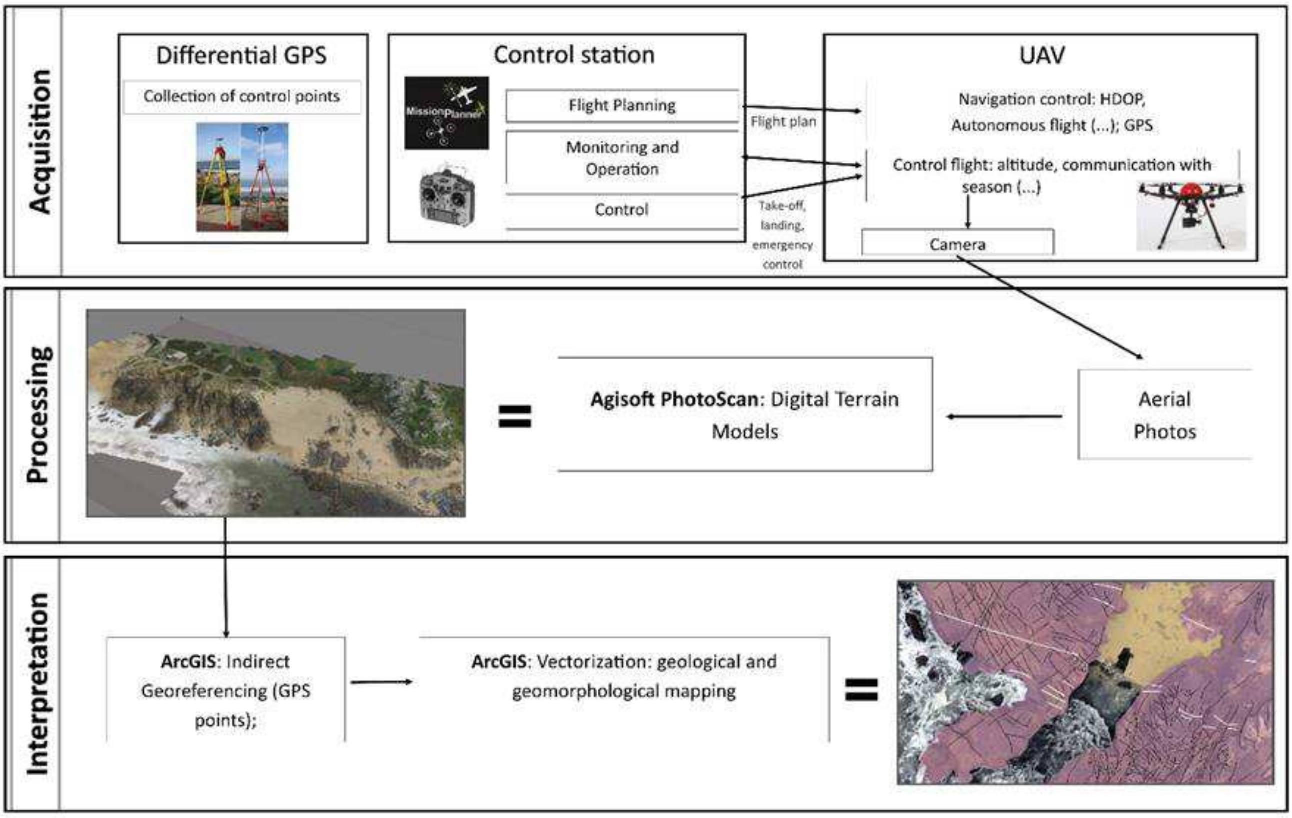


*Figure 1. Workflow of the project following the proposals of [7] and [8].*

The data vectorization process began with the visual interpretation of the various geological elements according to their characteristics. Considering the contrast of colour in relation to the surrounding rock and the association with very sharp linear forms the veins were distinguished. In addition, the same recognition properties allowed the discontinuities mapping. This mapping is more difficult than the veins, since the contrast of the colour is not so obvious due to the discontinuities reveal a darker colour, a more irregular shape and smaller length and width. In addition to the exposed recognition properties, interpretation was also experimented with changes in the observation scale, mainly in the interpretation of the veins and the discontinuities, in cases in which their continuity was not perceptible.

The global orthoimage allowed the definition of two dominant directions for the veins and discontinuities, NW-SE and NNW-SSE. The veins consists essentially of quartz and feldspar, corresponding to aplite-pegmatite textures, and a few number of uncommon lamprophyres veins. Some veins are rejected by short displacements or appear intermittently, but are clearly rejected. Strike-slips on the reefs are dominantly right. The pixel resolution of 5 centimetres makes it possible to identify the smallest discontinuities, as well as the fine veins. However, the high resolution and the advantage of being able to zoom in on the image sometimes becomes a difficulty, since it is often lost the notion of space and what have been mapped.

Regarding to the area lithology, since we cover the inter-tidal range, the variations of colour and tonality are quite large, which does not allow distinguishing with great clarity the lithological differentiation. The field knowledge acquired from the area reveals that there is only one type of granite with slight textured differences, and a metamorphic rock basement on the southern boundary of the map.

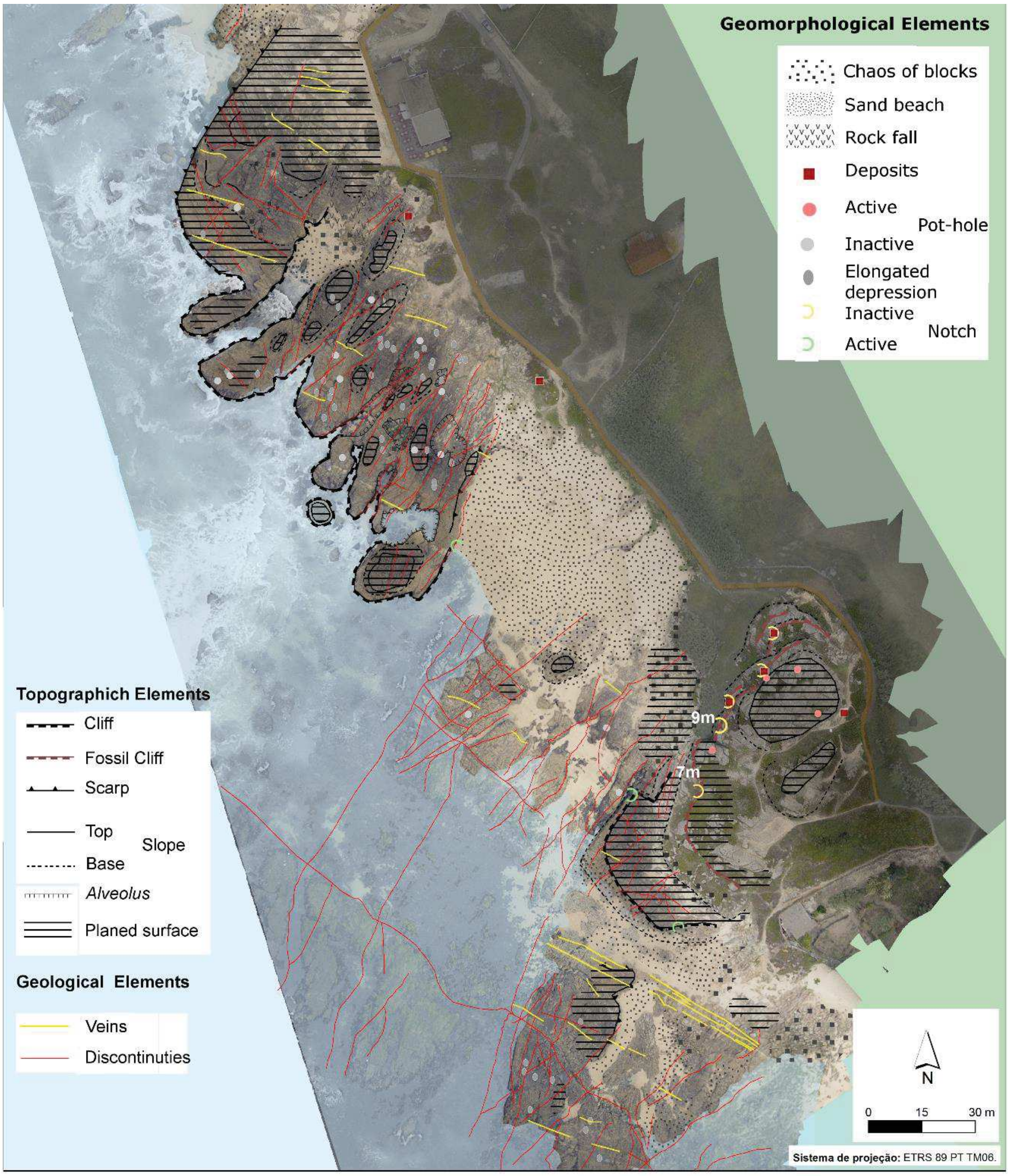


*Figure 2. Detailed geomorphological map of the São Paio littoral sector.*

Concerning to the geomorphology, the UAV data made it possible to recognize with high detail several coastal forms on the cliffs, on the platforms and at the granite hills that were unknown or badly characterized, giving precision to quantify their morphometric parameters (Fig. 2). Many coastal potholes at different altitudes, elongated topographic depressions and small flat surfaces were identified and mapped. With these new data, it was possible to distinguished clearly four geomorphological sectors that are quite evident on the longitudinal profiles and illustrates the huge altimetry variation of the surface, mainly due to discontinuities explored by the marine erosion.

In conclusion, the quality of the orthoimage obtained by the aerial photographs of the UAV to perform detailed cartography on this rocky coast was excellent. One great advantage comes from the precise and detailed characterization of geological and geomorphological features exposed in this work, such as the diversified veins, cliffs, erosion platforms, notches, coastal boulders, littoral potholes and even old deposits, in addition to the current sediments.

The use of UAVs in comparison with other data acquisition techniques is very advantageous since the costs and time spent in collecting and processing the data are relatively short. Processing images can even be carried out on-site, which allows an immediate result to be visualized and facilitates the correction of errors through repeated flights. Given these characteristics and the improvement of the geological interpretation of the rocky sector of São Paio obtained with these new data, it is assumed that the acquisition of data from this costal environment constitutes an important technique to apply in the studies of rocky coasts, especially for geomorphological studies [9], and possibly also for risk mapping. The flight easiness repetition and speed of data processing makes it accessible tool and very effective in monitoring and managing the rocky coasts.

**References:**

1. Emery, K.O. & Kuhn, G.G. (1982). Sea cliffs: their processes, profiles, and classification. *Geological in the Society of America Bulletin*. 93, 644–654.

2. Gómez-Pujol, L., Pérez-Alberti, A., Blanco-Chao, R., Costa, S., Neves, M. & Río, Laura Del (2014). The rock coast of continental Europe in the Atlantic. Rock Coast Geomorphology: A Global Synthesis. *Geological Society, Memoirs 2014*, 40, 77-88.

3. Sunamura, T (1992). Introduction. In Geomorphology of rocky coasts. *Wiley*, 1-4

4. Naylor, L.A., Stephenson, W.J. & Trenhaile, A.S. (2010). Rock coast geomorphology: Recent advances and future research directions. *Geomorphology*, 114, 3-11.

5. Araújo, M. A., Teixeira, J., Marques, M. (2014). A área do S. Paio (Labruge, Vila do Conde): desafios científicos e uso de novas tecnologias. *Atas do XIV Congresso Ibérico de Geografia*, 2200-2205.

6. Humphrey, D. (2014). UAV and GIS, an emerging dynamic duo. Available at <*http://www.esri.com/~/media/Files/Pdfs/news/arcuser/0314/uav-and-gis.pdf*>.

7. Sabins, F. (2007). Introduction to concepts and systems In Remote Sensing: Principles and Applications. *Waveland Press*, 2-31.

8. Kaneko, K. & Nohara, S. (2014). Review of Effective Vegetation Mapping Using the UAV (Unmanned Aerial Vehicle) Method. *Journal of Geographic Information System*, 6, 733-742.

9. Pérez-Alberti, A. & Trenhaile, A.S. (2015). An initial evaluation of drone-based monitoring of boulder beaches in Galicia, north-western Spain. *Earth Surface Processes and Landforms*, 40 (1), 105-111.